Dover Municipal Landfill Superfund Site
Second Consent Decree for RD/RA

Civil Action No. 1:92-cv-406-M

APPENDIX A-1

1991 ROD

(Part 1 of 6)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION I

J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

DECLARATION FOR THE RECORD OF DECISION

Dover Municipal Landfill
Dover, New Hampshire

STATEMENT OF PURPOSE

This decision document represents the selected remedial action for the Dover Municipal Landfill Site in Dover, New Hampshire, developed in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986, and to the extent practicable, the National Oil and Hazardous Substances Contingency Plan (NCP), 40 CFR Part 300 et seq., as amended. The Region I Administrator has been delegated the authority to approve this Record Of Decision.

The State of New Hampshire has concurred on the source control and eastern plume management of migration portions of the selected remedy and has reserved a concurrence decision for the southern plume management of migration portion of the selected remedy.

STATEMENT OF BASIS

This decision is based on the Administrative Record which has been developed in accordance with Section 113 (k) of CERCLA and which is available for public review at the Dover Public Library in Dover, New Hampshire and at the Region I Waste Management Division Records Center in Boston, Massachusetts. The Administrative Records Index (Appendix E to the ROD) identifies each of the items comprising the Administrative Record upon which the selection of the remedial action is based.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to the public health or welfare or to the environment.

DESCRIPTION OF THE SELECTED REMEDY

This ROD sets forth the selected remedy for Dover Municipal Landfill Site, which addresses source control and management of migration to meet cleanup goals. The selected remedy is multi-tasked. The remedial measures will protect the drinking water aquifer by minimizing further migration of contaminants to the groundwater and surface water, will eliminate threats posed by direct contact with or ingestion of contaminated soils and wastes at the Site and will prevent the ingestion and direct contact with contaminated groundwater and surface water.

The major components of the selected remedy include

- Recontouring of the existing landfill;
- Consolidation of sediments in the perimeter drainage ditch;
- Limited excavation and consolidation of sediments in the drainage swale and at the confluence to the Cocheco River;
- Capping of the landfill;
- Upgradient groundwater diversion;
- Groundwater/leachate collection and treatment;
- Pre-design studies which include the installation of additional monitoring wells;
- Natural attenuation of the "eastern" plume;
- Groundwater Extraction and treatment of the "southern" plume;
- Long-term environmental monitoring;
- Institutional Controls, where possible.

DECLARATION

The selected remedy is protective of human health and the environment, attains Federal and State requirements that are applicable or relevant and appropriate for this remedial action and is cost-effective. This remedy satisfies the statutory preference for remedies that utilize treatment as a principle element to reduce toxicity, mobility, or volume of hazardous substances. In addition, this remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

As this remedy will result in hazardous substances remaining onsite above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

Sept. 10 1991
Date

Julie Belaga
Regional Administrator
U.S. EPA, Region I

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 1

RECORD OF DECISION

DOVER MUNICIPAL LANDFILL SITE
DOVER, NEW HAMPSHIRE

ROD DECISION SUMMARY

Dover Municipal Landfill

TABLE OF CONTENTS

APPENDICES

DOVER LANDFILL ROD DECISION SUMMARY
SEPTEMBER 10, 1991

I. SITE NAME, LOCATION AND DESCRIPTION

A. General Description

The Dover Municipal Landfill Site (the Site) is a 55-acre inactive landfill in Dover, Strafford County, New Hampshire. The Site is located in the western corner of Dover, at the intersection of the Dover, Barrington and Madbury town lines. A locus map showing the general location of the Site is included in Appendix A as Figure 1.

About one-half mile north of the Site is the Calderwood Well, which supplies roughly 20 percent of the drinking water to the City of Dover. About 2000 feet south of the Site is the Bellamy Reservoir which provides drinking water for Portsmouth, Newcastle, Newington, Durham, Madbury, Greenland and Rye, New Hampshire. The Cocheco River lies 500 feet east of the Site.

The topography to the north, south and southeast of the Landfill is relatively flat. To the east, the topography is more undulating with a sharp drop in elevation toward the Cocheco River. Wetlands predominate northwest, west and southwest of the Landfill. The Landfill is bordered by Tolend Road and Glen Hill Road on the North, by Tolend Road on the east, and by private property on the southeast and the south. The Site is located in a rural area, although land along the east side of Tolend and Glen Hill Roads has been subdivided for residential use. A number of homes are located along these roads. Recreational uses near the Site include fishing in both the Cocheco River and the Bellamy Reservoir.

Additional information regarding the characteristics of Dover, New Hampshire may be found in Section 2, pages 2-1 and 2-2 of the Remedial Investigation (RI) conducted by the State of New Hampshire's contractor; Wehran Engineers and Scientists (Wehran) and in Section 2, page 2-1 of the Field Element Study conducted by HMM Associates, Inc (HMM), the contractor for the Dover Landfill PRP Steering Committee. Site characteristics, analytical results and remedial alternatives have been presented in the following documents prepared by Wehran and HMM:

Remedial Investigation Report, Dover Municipal Landfill, Dover, New Hampshire., Wehran Engineers and Scientists, November 1988.

Field Elements Study and Supplemental Risk Assessment for the Municipal Landfill, Dover, New Hampshire, Hmm Associates, Inc., February, 1991.

Dover Municipal Landfill Feasibility Study, Dover, New Hampshire, HMM Associates, Inc., February, 1991.

B. Geology and Hydrology of the Site

The geology of the Site area is typical of the southeastern New Hampshire region. Unconsolidated overburden deposits, generally of glacial origin, are underlain by consolidated, usually metamorphic, bedrock. Unconsolidated overburden deposits include a wide variety of grain sizes reflecting historic changes in depositional environment. These deposits appear to divide into two generalized aquifer units, an upper and lower, separated by a clay aquitard that appears to have effectively limited groundwater contamination to the upper aquifer.

The upper aquifer unit contains a sand zone and an underlying finer grained, interbedded zone. The sand zone is composed of fine to medium grained sand with occasional silt and organic matter and traces of clay sized material. The sand unit ranges in thickness from 10 feet (at well B-12L) to 33 feet (MW-105U). The interbedded zone above the clay aquitard (the upper interbedded zone) consists of interbedded silt and clay layers. This unit has lateral and vertical hydraulic conductivities less permeable than the overlying sand, and ranges in thickness from 0 feet (MW-106L) to 70 feet (MW-102U).

The clay aquitard consists of a gray marine clay unit with very low permeability. The clay unit thickness ranges from 12 feet (MW-106L) to 42 feet (MW-105U). The upper surface of the unit is at a higher elevation and near land surface north and west of the Landfill at wells B-13, B-14 and MW-106. The upper surface is irregular and depressions or localized lows may occur in the vicinity of wells B-4, B-6, B-8 and B-2. This unit appears to pinch out in the vicinity of B-14; north of this location the lower and upper aquifers are no longer separated by a low permeability unit.

The lower aquifer unit has three distinct zones, none of which are continuous. Just below the clay zone is the lower interbedded zone which exhibits grain sizes and permeabilities similar to that of the upper interbedded zone. This zone is thickest (up to 50 feet at B-1) north of the Landfill, where it also contains a thick sandy zone. It appears to terminate south and west of the Landfill. Its permeability characteristics appear similar to those of the upper interbedded zone. Beneath the lower interbedded zone is a highly permeable sand and gravel zone. Its thickness is quite variable. At MW-101, next to the Landfill, it is approximately 20 feet thick, while east of this location at B-9 it is approximately 40 feet thick. West or northwest of MW-101 it appears to pinch out (as between B-7 and MW-106). This zone is hydraulically connected to the Calderwood Well, and may provide a significant proportion of the water derived from that well. Beneath the sand and gravel zone is a tightly packed poorly sorted glacial till of low permeability. Where till occurs it lies directly on the bedrock; where till does not occur, the sand and gravel zone lies directly on the bedrock.

The Landfill is underlain by rocks of the Berwick Formation. Rock samples recovered were predominantly unweathered to slightly weathered micaceous quartz-biotite granobels. Sulfides (pyrrholite, massive pyrite) were observed to be common accessory minerals. Other lithologies observed included calc-silicate and carbonaceous phyllitic siltstone.

The bedrock appears to be moderately fractured with occasional highly fractured zones. Fractures generally paralleled bedding and foliation. Orientation of the fractures was generally in a northeast-southwest direction with dip angles moderate to steep toward the north. The depth to bedrock varies from about 23 feet (B-3R) to about 143 feet (B-11R) below land surface. The bedrock high of 130 feet above sea level is at B-3, and it slopes southward and eastward to a known low of about 11 feet below sea level at B-12R.

Groundwater in the upper aquifer moves essentially from an area north of the Landfill south towards the Bellamy Reservoir and east to the Cocheco River. To a lesser degree, groundwater also moves downward through the upper aquifer. Movement of groundwater into the lower aquifer is effectively inhibited by the presence of the marine clay aquitard.

Groundwater movement in the lower aquifer (in the landfill vicinity) moves northeastward under the influence of the pumping of the Calderwood Well. Water levels in the bedrock aquifer suggest upward movement into the lower aquifer and lateral movement towards the Calderwood Well.

Additional information about the Site geology and hydrology can be found in the Remedial Investigation on pages 5-1 through 5-29 and in the Field Element Study on pages 2-26 through 2-28 and pages 3-16 through 3-31.

C. Groundwater Supply

Two public water supplies are located in the vicinity of the landfill, the Calderwood well and the Bellamy Reservoir. The Calderwood well is located one half mile north of the Site. The Calderwood Well is a gravel-pack well approximately 114 feet deep. It is currently pumped at a rate of approximately 400 to 500 gpm or 576,000 to 720,000 gallons per day (GPD).

The Bellamy Reservoir is located approximately 1,700 south-southwest of the landfill and is a drinking water supply for the towns of Portsmouth, Newcastle, Newington, Durham, Madbury, Greenland, and Rye, New Hampshire. The drainage basin for the reservoir comprises approximately 22 square miles. The 420-acre reservoir has an average depth of 6 to 7 feet and an estimated usable storage capacity of 865 million gallons. Two water intakes connected to the City of Portsmouth Water Treatment Facility are located at the reservoir dam on Mill Hill Road, approximately 2 miles to the south of the Site. 2.0 to 2.8 million gallons per day (mgd) of water from the reservoir is treated prior to release into the Portsmouth water supply distribution system.

Residential wells near the Site obtained water from both the lower and upper aquifer. In 1981, contamination was found in the residential wells closest to the Site and situated in the upper aquifer, which also underlies the Landfill. The City of Dover installed a water supply line along Glen Hill and Tolend Roads during 1983, and residents closest to the Site were connected to the main at that time. Additional residential connections, further from the Landfill, continued until the fall of 1989.

A more complete description of the Site can be found in the Remedial Investigation Report on Pages 2-1 through 2-4, 4-3,and 4-4 and in the Field Element Study on pages 2-4 through 2-8.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

A. Land Use and Response History

Operation of the Dover Municipal Landfill reportedly began about 1960 and ceased in 1979. The Dover Municipal Landfill accepted wastes, including liquids and sludges from both domestic and industrial sources. The waste materials included, among other things, domestic and industrial sludges, shoe and leather tanning waste products, organic solvents, waste oil, and municipal solid waste. Table 1 found in Appendix B of this ROD provides a list of the types of industrial wastes, compiled from an industrial waste survey taken by The State of New Hampshire in 1976, that were disposed of at the Landfill from 1976-1977. Closure operations at the Site, conducted by the City of Dover, included a sandy-loam cover and surface water/leachate drainage channel construction, and site access control.

Landfill disposal practices varied during operation. They evolved from trenching, to burning, to a fill and cover method in 1962. Fill and cover operations were begun at the eastern portion of the present Landfill area and progressed westward until 1977 where it appears the current areal extent of the Landfill was reached. Disposal continued at the Landfill on top of previously deposited material. Drums of industrial waste were accepted at the Landfill until at least 1975. Since detailed records of each load of refuse brought to the Landfill were not kept, a detailed quantification and characterization of the waste buried cannot be calculated.

Liquid wastes were historically brought to the Landfill and reportedly disposed of by being poured onto the surface of existing refuse. If the wastes were flammable, during the early years of the Landfill's operation they were ignited and burned. Empty containers, such as drums, were crushed and disposed of with the municipal refuse. Some chemical wastes were known to have been disposed of at the Landfill while still in drums.

Landfill closure operations, by the City of Dover, consisting of placing clean fill over the existing material, were completed in March, 1980. One or two years later, the Landfill was closed for the interim as a part of a cooperative effort between the State and the City of Dover, and the drainage ditch was re-excavated around the Landfill consistent with its current configuration for the purpose of intercepting leachate and thereby limiting off-site contaminant migration.

Dover City officials along with the New Hampshire Water Supply and Pollution Control Commission (the Commission has since been incorporated as a Division within the New Hampshire Department of Environmental Services and is herein referred to as the NHDES) initiated a groundwater monitoring program at the Landfill in 1977. In 1980, the monitoring program was expanded to include several residential wells. Contamination was first found in a private residential well near the Landfill in February, 1981.

Subsequent samples, collected by the NHDES, were taken to determine whether the Landfill was the source of the contamination detected in the private water supplies. Surface water sampling and analyses were conducted by the NHDES in March and April, 1977, and by the City of Dover and the City of Portsmouth Water Departments in April, May and September, 1981 and in March, 1982.

The Landfill was evaluated as a potential hazardous waste site by the U.S. Environmental Protection Agency (EPA), ranked, and proposed for the EPA's National Priorities List (NPL) on December 30, 1982. The Site was placed on the NPL on September, 8, 1983. In accordance with the requirements of the National Contingency Plan (NCP), a Remedial Action Master Plan (RAMP) was prepared for the site in 1983. The RAMP included a recommended scope of services for remedial action planning activities at the site, and called for completion of a Remedial Investigation/Feasibility Study.

The Remedial Investigation (RI) for the Dover Municipal Landfill was conducted by the NHDES under a cooperative agreement with the EPA. The NHDES contracted with Wehran Engineers and Scientists to conduct the RI. The Field Element Study (FES), which addresses the data gaps of the RI, and the Feasibility Study (FS) were conducted by a group of Potentially Responsible Parties (PRPs) for the Site under an Administrative Order by Consent with EPA. The PRPs contracted with HMM Associates, Inc. to conduct these activities. The RI was completed in March 1989 and the FES and FS were completed in February 1991.

A more detailed description of the Site history can be found in the Remedial Investigation Report on pages 1-5 through 1-9 and in the Field Element Study on pages 2-1 through 2-8.

B. Enforcement History

In the spring of 1987 the City of Dover and several Dover businesses formed a PRP group and expressed to the Agency an interest in undertaking the Feasibility Study (FS) and filling the data gaps left by the RI. Negotiations between EPA and the PRP group were undertaken in the late summer 1987. After extended neogtiations, the City of Dover and eight businesses signed an Administrative Order by Consent (AO) with EPA and the State of New Hampshire in July 1988. In that Order the PRPs agreed to pay some past costs associated with the RI, to conduct a Field Element Study (FES) to fill data gaps left by the RI, and to conduct the FS. The Order also provided that additional parties could sign-on without renegotiating the terms of the

Order; an additional fourteen (14) PRPs have since signed the Order. The PRPs contracted with HMM Associates, Inc. to conduct these activities. The FES and FS were completed in February 1991.

In late January 1988 the City of Dover and four businesses were sent formal notice of their potential liability for the remediation of the Site. In late March and early April 1991, after an extensive PRP search, general notice was sent to 39 potentially responsible parties, including those PRPs already sent notice. Copies of the Proposed Plan were sent to all noticed parties as well as to public representatives and the news media to provide an opportunity to comment on the EPA's preferred Remedial Alternative. On April 15, 1991 EPA met with the PRPs to discuss their potential liability at the Site. At the request of EPA, the PRPs have been active in forming a new steering committee to consider the performance and financing of the Remedial Design and Remedial Action (RD/RA).

The PRPs have been active in the remedy selection process for this Site. Technical comments presented by PRPs during the public comment period and at the Public Hearing were evaluated, summarized in writing, and the summary and written comments are included in the Administrative Record.

III. COMMUNITY PARTICIPATION

Until April 1991, community concern and involvement at the Site had been relatively low. EPA has kept the community and other interested parties apprised of the Site activities through informational meetings, fact sheets, press releases and public meetings.

During December, 1984, EPA released a community relations plan which outlined a program to address community concerns and keep citizens informed about and involved in activities during remedial activities. On August 9, 1983 EPA and the NHDES held a meeting at the Dover City Hall auditorium to discuss the findings and recommendations of the Remedial Action Master Plan (RAMP). On December 13, 1984, NHDES held an informational meeting in the Dover City Hall auditorium to describe the plans for the Remedial Investigation and Feasibility Study. On March 30, 1989 NHDES and the EPA held an informational meeting in the Dover City Hall auditorium to discuss the results of the Remedial Investigation.

On March 16, 1991, EPA made the Administrative Record available for public review at EPA's offices in Boston and at the Dover Public Library in Dover, New Hampshire. EPA published a notice

-Further contamination of groundwater through the leaching of contaminants from the landfill.

-Direct contact with contaminated soils, sludge, sediments and debris found in the Landfill.

-Ingestion of contaminated soils, sludges, sediments and debris found in the Landfill.

-The off-site migration of contaminants in groundwater.

-Ingestion and direct contact with contaminated groundwaters and surface waters.

Remedial activities at the Site are comprehensive and designed to be a final remedy.

V. SUMMARY OF SITE CHARACTERISTICS

Section 1 of the FS contains an overview of the Remedial Investigation and Field Elements Study. Contamination at the Site is a result of the disposal of hazardous substances in the Landfill and the leaching of contaminants into the surrounding groundwater, surface waters, soils and sediments.

Analysis of soil, groundwater, sediment and surface water from areas in and around the Landfill indicate that the contamination at the Site is found primarily in the groundwater, surface water and sediments. The Landfill itself presents a potential threat as it may conceal containers of hazardous substances.

The most prevalent contaminants identified in groundwater at the Site are Volatile Organic Compounds (VOCs) such as 1,1,1-Trichloroethane (TCA) and degradation products of TCA such as 1,1-Dichloroethylene (DCE) and 1,2-Dichloroethane (DCA); acetone, benzene, toluene, and tetrahydrofuran. Also identified in the groundwater are trichloroethylene (TCE), ethylbenzene, xylenes, tetrachloroethylene, chloroethane, methyl ethyl ketone, methyl isobutyl ketone, vinyl chloride and methylene chloride. Arsenic was the prevalent metal found in the groundwater.

The significant findings of the Remedial Investigation and Field Element Study are summarized below.

A. Soil

Soil investigations were conducted at the Dover Landfill during the Remedial Investigation and also during the Field Elements and brief analysis of the Proposed Plan in Foster's Daily Democrat on March 22, 1991 and made the plan available to the public at the Dover Public Library. The Proposed Plan included notice of a proposed waiver for the Safe Drinking Water Act, Maximum Contaminant Level (SDWA MCL) for arsenic in groundwater.

On March 25, 1991 EPA held an informational meeting at the Horne Street Elementary School to discuss the results of the Remedial Investigation, Field Elements Study and the cleanup alternatives presented in the Feasibility Study, and to present the Agency's Proposed Plan. Also during this meeting, the Agency responded to questions from the public. From March 26, 1991 to May 24, 1991, the Agency held a sixty day public comment period to accept public comment on the alternatives presented in the Feasibility Study and the Proposed Plan and on any other documents previously released to the public. On April 16, 1991 the Agency held a public meeting to discuss the Proposed Plan and to accept any oral comments. A transcript of this meeting and the comments from the general public, Dover and Madbury City officials and from representatives of the Dover Landfill Steering Committee along with the Agency's response to comments are included in the attached Responsiveness Summary.

IV. SCOPE AND ROLE OF RESPONSE ACTION

The selected remedy was developed by combining components of different source control and management of migration alternatives to obtain a comprehensive approach for site remediation. In summary, the remedy provides for recontouring the existing landfill surface and construction of a 55-acre multi-layer cap over the landfill to prevent infiltration and promote run-off and the installation of a leachate and contaminated groundwater collection system around the perimeter of the landfill. The contaminated groundwater and leachate would then be treated on-site by a Powdered Activated Carbon Treatment System (PACT™) or equivalent system with discharge to the Cocheco River or pretreatment and discharge to the Dover Publicly Owned Treatment Works (POTW). There will be a limited excavation of the contaminated sediments from the existing drainage swale. These excavated sediments would be placed onto the landfill prior to capping. Natural attenuation processes will be utilized to attain groundwater cleanup levels in the eastern plume while a groundwater extraction and treatment system will be employed to attain cleanup levels in the southern plume.

The remedial action will address the following primary risks and principal threats to human health and the environment posed by the Site:

Study to address specific data gaps. Specifically, Base\Neutral and Acid extractable organic compound (BNA) contamination was detected in the soils between the drainage ditch and well cluster B-13 during the RI. Contamination at these locations was found to be below minimum detection limits during FES investigations.

A limited study of the potential locations of buried drums at the Landfill was conducted as part of the RI using surface geophysics. Test pits (excavations into the waste material) were also conducted. Crushed drums were found in many of the test pits throughout the Landfill. No definable areas of excessively high contamination, highly mobile sludges or large volumes of liquid filled drums (hot spots) were found in any of the test pits in the Landfill. The locations of the test pits can be seen in Figure 2 of Appendix A of this ROD.

Soil samples were obtained from the unsaturated zone within selected test pit excavations on the Landfill during the RI. VOCs were detected in single soil samples obtained from the following test pits:

Test Pit and location at the Landfill	Total VOC Concentration
TP-1 - northern part of the Landfill	475 ug/kg
TP-16- northwestern part of the Landfill	8,410 ug/kg
TP-19- southeastern part of the Landfill	680 ug/kg
TP-20- southwestern part of the Landfill	20,330 ug/kg

Primary VOCs observed, in terms of relative concentration or frequency include:

- ethylbenzene
- toluene
- xylene
- methyl butyl ketone
- acetone
- methyl ethyl ketone

Other soils sampled from the drainage ditch surrounding the Landfill, including the wetlands and the discharge stream, are described in the sediments discussion.

B. Surface Water

The RI included surface water and sediment samples from the perimeter drainage ditch and discharge stream of the wetland areas. Surface water samples did not detect the presence of elevated levels of metals or BNAs. VOC contamination was found in the surface water samples taken from the drainage ditch from sampling locations SW-2 and SW-5. Samples taken during the RI from SW-2 (from the northern and upgradient side of the Landfill) contained total VOC concentrations as high as 1,819 ppb and the SW-5 sample (from the east side of the Landfill) contained 431 ppb. These data indicate that the drainage ditch is a predominant avenue for contaminant movement, including groundwater discharge, flowing from the Landfill and discharging into the Cocheco River.

The perimeter drainage ditch does not completely freeze over in the winter, indicating that exothermic conditions are present as a result of leachate from the Landfill entering the drainage ditch and affecting water quality and temperatures. This condition may also be a contributing factor with regard to the limited vegetative establishment in and around the ditch.

Surface water samples were collected as part of the Field Elements Study from the Cocheco River (a class B waterway), the Bellamy Reservoir (a class A surface water), and the culvert drainage area just northeast of Glen Hill Road as can be seen in Figure 2. The total concentration of VOCs (BNAs and metals were not analyzed) at SW-1 (taken at intersection of drainage culverts) was 50 ppb and at SW-2 (taken at the point of discharge to the Cocheco River) was 153 ppb. Additionally, EPA split samples indicated the presence of a combined total of 19 ppb of vinyl chloride, 1,2-dichloroethane, 1,1,1-trichloroethane, trichloroethene, benzene, 1,1-dichloroethane and ethyl benzene from station SW-2. VOCs identified in the surface water in the drainage ditch included:

- acetone
- 1,2-dichloroethylene
- methylene chloride
- methyl ethyl ketone
- methyl isobutyl ketone
- tetrachloroethylene
- tetrahydrofuran
- toluene
- xylene

Samples from the Bellamy Reservoir indicated no detectable levels of VOC contamination. The sampling of the Cocheco River indicated VOCs at the intersection of the drainage swale and the river (SW-2) and a trace amount of methylene chloride, further downriver.

Surface water samples were also taken as part of the Treatability Study. Surface water samples were analyzed for various parameters such as BOD, COD, TSS, etc. The complete list of parameters analyzed for can be found on Table 1-5 of the FES. Laboratory results for Treatability Study surface water parameters are shown on Table 1-15 of the FES.

C. Sediments

Sediment sampling occurred in four general areas during the RI: the perimeter drainage ditch, the Cocheco River, the Bellamy Reservoir and the wetland locations north and west of the landfill. The highest levels of contamination were found within the perimeter drainage ditch and at the discharge point of the drainage swale into the Cocheco River. VOCs were detected in sediment sample S-5, including methyl ethyl ketone and trichloromethane at concentrations of 1700 and 400 ug/kg, respectively. Cadmium and arsenic were detected above anticipated background levels at stations S-5 and S-7. No VOC or BNA contamination was detected in the Bellamy Reservoir.

Results of the sediment sampling episode in the FES indicate some elevated concentrations of metals, principally arsenic and cadmium. The common range for arsenic in soils across the United States is 1 to 50 ppm, and for cadmium it is 0.01 to 0.70 ppm. Exceedances of the common range for arsenic were found at stations SD-1, SD-3, and SD-6 with concentrations of 51, 210 and 99 ppm, respectively. Each of these samples were collected from the drainage ditch around the Landfill or from the area where the drainage ditch culverts discharge to the swale that runs to the Cocheco River. Exceedances for cadmium were found at stations SD-4, SD-9, SD-10 and SD-16 with concentrations of 1.54, 1.16, 1.41 and 3.31 ppm, respectively.

Both lead and mercury concentrations were elevated in off-site station SD-2, and at station SD-9 located just upstream from where the culvert drainage waters enter the Cocheco River. The lead concentration from SD-16 (just south of Minichiello Brothers), and SD-8 (on the floodplain of the Cocheco River), were also relatively high. With the exception of suspected laboratory contaminants that were detected in four BNA samples, no other contamination was detected in the wetland sediments.

Sediment samples were collected for Total Organic Carbon (TOC) and sediment grain size analysis. Results of the TOC laboratory analysis are shown on Table 1-10 and results of the sediment grain size analysis on Table 1-11 of the FES. Actual laboratory reports of the analysis are shown in Appendix III of the FES. The discussion of sediments in the Remedial Investigation can be found on pages 7-4 through 7-7 and in the Field Element Study on pages 3-56 through 3-64.

D. Air

On September 11, 1990, EPA's Environmental Services Division (ESD) from Lexington, Massachusetts, conducted an eight hour air sampling program at five locations on and around the Dover Landfill site. The air sampling program involved collecting eight-hour ambient air samples on prepared Tenax sorbent cartridges and analyzing these sample cartridges with a gas chromatograph/mass spectrometer (GC/MS) at ESD's facility. The five stations were selected by the EPA based on previously obtained site-specific information and the objectives of this air sampling program, and concentrated in areas of high contamination found in the drainage ditch and swale which discharges to the Cocheco River.

The results, presented in Table 1-12 of the FS, showed low levels of VOCs in the air and were incorporated into the risk assessment (Section 2.0 of the Feasibility Study). The risk assessment evaluated potential health effects to humans from exposure to the contaminants at the concentrations detected.

In conjunction with this air sampling program, the EPA collected surface water/leachate samples from three of the five air sampling locations (locations #1, #3 and #4). The results from the analysis of these surface water samples are listed in Table 1-13 of the FS. The results from the surface water sampling program were evaluated to determine if volatilization of contaminants from the discharge stream was impacting the levels of contaminants in the ambient air on and around the site. The analytical results from the air samples collected from locations not impacted by the leachate in the drainage ditch (stations #2 and #5) and the stations impacted by volatilization of contaminants from the leachate in the drainage ditch (stations #1, #3 and #4) indicate that there is no significant impact to the on-site, ambient air quality from volatilization of contaminants from the leachate in the drainage ditch.

E. Wetlands Analysis

Wetland scientists from HMM Associates carried out a limited field investigation on March 27, 1990 of the wetland resource areas identified within and adjacent to the boundaries of the Dover Landfill. Various reference sources were used in the initial Field Elements Study to identify potential wetland resource areas. These sources included:

- Soil Survey of Strafford County, New Hampshire, March 1973

- Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) for the Town of Dover, New Hampshire, Strafford County, Community Panel No. 330145 0005B, Effective Date: April 15, 1980

- National Wetland Inventory, Dover West, New Hampshire, April, 1977

- New Hampshire Department of Transportation (NHDOT) Wetlands Map

Further on-site review and verification of the related information indicated that there are four wetland systems in the vicinity of the Dover Landfill. Three of these wetland systems are described as the Bellamy Reservoir, Cocheco River, and the Hoppers System north of the site. The fourth wetland area includes the man-made drainage ditch which extends around the perimeter of the Landfill which is hydraulically connected with the Bellamy Reservoir wetland system. Delineation of the wetland areas are shown on Figure 3. The drainage ditch is not cross-hatched as are the other three areas on Figure 3.

These wetland systems were reviewed for evidence of physical effects on vegetation that could be attributed to the Dover Landfill. The review was limited in scope due to seasonal constraints in that no herbaceous vegetation could yet be seen. However, the woody vegetation exhibited no observable signs of stress-related conditions. With the exception of the drainage ditch and swale to the Cocheco River, the standing pockets of water throughout the systems were relatively clear and exhibited no signs of foaming or discoloration. Thus, there was no visible evidence that these wetland systems have been impacted by the Dover Landfill. The drainage ditch waters were observed to have foam on the water. In addition, although the temperature was such that area water bodies had ice cover, the drainage channels close to the landfill were not frozen. These factors suggest that leachate from the landfill is affecting the water quality and temperature of these surface waters.

F. Groundwater

Groundwater contamination (VOCs, metals, and BNAs) was found at several locations around the Dover Landfill. All three of these contaminant types were encountered in the upper aquifer just downgradient of or near the Landfill. The lower aquifer was not found to contain consistent or reproducible levels of contaminants in current or RI data. Contamination in well OW-1 was detected during the RI on several occasions possibly due to faulty well joints or construction, and therefore the well was abandoned in January 1988. Faulty joint connections were also corrected on well B-2. Figures 4 through 8 show total VOC, BNA and arsenic contaminant concentrations for groundwater for the upper and lower aquifers. "ND" indicates that contaminant levels were below the minimum detection level (MDL) of the instrument performing the analysis.

<u>VOCs</u> - Figure 4 depicts the concentrations of VOC data for groundwater samples collected from the upper aquifer at the Site, and Figure 8 shows the estimated extent of known VOC contamination related to the Landfill from the RI and FES in areas directly influenced by the Landfill. Generally, the November 1989 sampling results suggest that the VOC plume is attributable to hazardous substances in the Landfill and is moving in an east, southeastward direction. Figure 8 presents the estimated limit of contamination in the groundwater. The upper aquifer exhibits semi-radial groundwater flow (see Figure 9) with contamination generated by the Landfill being detected at monitoring well clusters B-2 to the east, toward the Cocheco River; southeast of the Landfill at MW-103, 104, OW-5 and B-6; and along the southern edge of the Landfill at clusters B-8 and B-4. Analytical data collected to date do not indicate that contaminants have migrated as far south as clusters MW-102 or B-10. VOC contamination was found in upper aquifer wells MW-101U, OW-1A, MW-104S, MW-104U, MW-103S, MW-103U, B-2U, B-4U, B-8U and OW-5 during the November, 1989 sampling episode. The highest concentrations of total VOCs for the site were detected at MW-101U (2,174 ppb), B-4U (760 ppb), OW-5 (744 ppb) and OW-1A (733 ppb). These analytical results indicate that the predominant mass of contaminants is migrating to the east/southeast toward the Cocheco River. Contaminants from the northwestern area of the Landfill appear to be flowing toward the Bellamy Reservoir. The estimated location and apparent historical trends for this data are provided on Figure 8. VOCs were found in some private residential wells near the Landfill in 1981. Residents near the Landfill were then connected to the City's water supply. At this time, only two residential wells (RW-3 and RW-21) are still being used for drinking water purposes. Of these two wells, RW-3 is in the lower aquifer, and the depth of RW-21 is unknown.

<u>Residential Wells</u> - Residential wells located in the vicinity of the Dover Landfill were sampled and analyzed for VOCs during numerous sampling episodes of the RI. Results of these analyses are shown on Figure 9. Contaminants were detected in wells RW-8 and RW-9 during the March 1981 sampling episode at 78 ppb and 10 ppb total VOCs respectively; and in wells RW-8, RW-17,

RW-18 and RW-21 at 10, 10, 95, and 62 ppb total VOCs respectively, in the May, 1985 sampling episode. No detectable levels of VOC were observed in the residential wells sampled after 1985.

Metals - Arsenic is the only metal with concentrations that exceed State and Federal drinking water standards of 0.05 parts per million (ppm). Concentrations of unfiltered arsenic from the November, 1989 FES sampling event varied widely across the site from 0.021 to 1.3 ppm in areas adjacent to the Landfill exhibiting VOC contamination and 0.003 to 0.09 ppm in areas where VOC contamination was not detected.

Arsenic occurs naturally in the soil matrix at the site and has been observed in other areas of southern New Hampshire. Other studies of New Hampshire groundwater indicate that, where elevated arsenic levels in water supplies are found it may be the result of natural geologic conditions. Arsenic has been found where no VOC contamination has been detected (including upgradient samples) as well as in samples associated with the VOC plume within the upper aquifer emanating from the Landfill. Figure 6 depicts the concentrations of arsenic found in the groundwater samples from the upper aquifer. Arsenic is also found at measurable concentrations in groundwater samples from the lower aquifer at wells B-6L and OW-3A, where VOC contamination had been detected during the RI but below minimum detection levels during the FES.

Filtered and unfiltered groundwater samples were obtained at various wells in the upper aquifer around the Landfill. Results indicate that arsenic is present in both, suggesting that particulate and dissolved forms of arsenic are present in groundwater in the upper aquifer. The particulate arsenic is that component adsorbed to soils or bound within the soil matrix. The presence of arsenic in the unfiltered groundwater samples and in background groundwater and sediment samples, including upgradient locations, suggests that arsenic is a naturally occurring element of the area's geologic formations.

The higher arsenic concentrations found in close proximity to and downgradient of the landfill relative to concentrations found elsewhere in the study area suggests that they are a result of landfilling activities. The waste materials disposed of at the landfill may be the source of the arsenic, or the leachate from the landfill may produce changes in groundwater geochemistry such that native arsenic is being mobilized.

BNAs - BNA contaminants were found in groundwater samples from the upper aquifer in November, 1989 (wells B-13U, OW-5 and MW-104S). Monitoring well B-13 showed low levels of contamination during the RI, but subsequent sampling did not indicate any sources. The area around B-13 is adjacent to a dirt road and is heavily traveled by recreational vehicles. It is possible that this BNA sampling reflected random spills as opposed to the effects of a leachate seep from the Landfill. Therefore, only the shallow wells MW-104S, OW-5, B-6U and B-2U located in a narrow band directly adjacent to the eastern edge of the Landfill are suspected to have BNA contamination derived from the Landfill.

PCBs/Pesticides - Groundwater from the Landfill was not found to contain any PCBs or pesticides from any of the analytical laboratory sampling results from either the upper or lower aquifers.

A complete discussion of site characteristics can also be found in the Remedial Investigation Report on Pages 7-1 through 7-15 and in the Field Element Study on Pages 5-1 through 5-15.

G. GROUNDWATER CONTAMINANT TRANSPORT

The Cocheco River and the Bellamy Reservoir are considered potential receptors of contaminants migrating from the Landfill. Residential wells have already been impacted by the migration of contaminants in the upper aquifer. The Calderwood well is also considered a potential, though less likely, receptor of the contamination form the Landfill.

Contaminants at the Site may enter the groundwater flow regime via percolation of liquid wastes disposed on the ground surface, infiltration of precipitation through contaminated solids, and direct subsurface discharges from leaking drums.

During the RI, VOC, BNA, and metals contamination in groundwater was observed to be most prevalent in the upper aquifer at monitoring well locations within 400 feet or less from the Landfill. Contamination detected in the lower aquifer monitoring wells is not indicative of transport of contamination from the Landfill through the marine clay layer to the lower aquifer. As was stated earlier, the results of contamination in the lower aquifer in well OW-1 may reflect leakage of contaminated groundwater from the upper aquifer through the PVC well pipe joints. This well has since been decommissioned.

The RI groundwater transport model provides an estimate of contaminant migration from the Landfill source area easterly and southeasterly toward the Cocheco River and private residential wells located along Tolend Road, and southerly toward the Bellamy Reservoir. The concentration isopleths depicting the contaminant plume predicted by each model simulation over time are found in the RI as Figures 25 through 30. Modeling results suggest that contaminated groundwater will reach the east bank of the Bellamy Reservoir, south of the Landfill, between approximately 1990 and 2005. Advective transport times are estimated to be on the order of 100 to several hundred years for the transport of contaminants from the upper aquifer through the marine clay layer. Contaminant transport times to the Calderwood well predicted by the model are on the order of 40 to 80 years after contaminant breakthrough to the lower aquifer.

HMM Associates, the contractor performing the FES for the PRP Steering Committee, also developed and utilized a groundwater contaminant transport model. Data during the FES indicated that the primary direction of groundwater flow was east/southeast towards the Cocheco River and that a small flow was south towards the Bellamy Reservoir. Field data during the FES also indicated that groundwater transport velocities may be slower than the RI had predicted. Additional sampling rounds indicate that the contamination has not migrated beyond the non-detect plume estimated by the RI.

The results from the FES groundwater model predicted that through natural attenuation it would take 5 to 7 years for the contamination in the eastern plume to attain groundwater cleanup levels and 10 to 24 years to attain cleanup levels in the southern plume once source control measures were implemented (including capping and leachate/ groundwater collection). Since monitoring well B-8u was installed with an 80 feet screened interval, it is currently unknown whether the contamination is primarily in the upper, unconsolidated layer, hence the 10 year attenuation time frame, or in the lower interbedded layer, which yields a time frame for attenuation of 24 years. The FES groundwater model also predicted that it is not likely that groundwater contamination will reach the Bellamy Reservoir, but if it did, it would do so below the Safe Drinking Water Act MCLs.

VI. SUMMARY OF SITE RISKS

A Risk Assessment (RA) was performed to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants associated with the Site. The public health risk assessment followed a four step process:

1) contaminant identification, which identified those hazardous substances which, given the specifics of the site, were of significant concern; 2) exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure; 3) toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances, and 4) risk characterization, which integrated the three earlier steps to summarize the potential and actual risks posed by hazardous substances at the site, including carcinogenic and non-carcinogenic risks. The results of the public health risk assessment for the Dover Municipal Landfill Site are discussed below followed by the conclusions of the environmental risk assessment.

Sixteen contaminants of concern, listed in Table 2 found in Appendix B of this Record of Decision were selected for evaluation in the risk assessment. These contaminants constitute a representative subset of the more than 41 contaminants identified at the Site during the Remedial Investigation and Field Element Study. The sixteen contaminants of concern were selected to represent potential site related hazards based on toxicity, concentration, frequency of detection, and mobility and persistence in the environment. A summary of the health effects of each of the contaminants of concern can be found in Chapter 4 of the Field Elements Study and Supplemental Risk Assessment (FES).

Potential human health effects associated with exposure to the contaminants of concern were estimated quantitatively through the development of the following four hypothetical exposure pathways:

- Future potential use of groundwater as drinking water
- Future potential use of Bellamy Reservoir as drinking water
- Incidental ingestion and dermal contact with surface water (Cocheco River and perimeter swale) while swimming or wading
- Ingestion and dermal contact with soil/sediment while swimming or wading

These pathways were developed to reflect the potential for exposure to hazardous substances based on the present uses, potential future uses, and location of the Site. The following is a brief summary of the exposure pathways evaluated. A more thorough description can be found in Chapter 4 of the FES. For each pathway evaluated, an average and a reasonable maximum exposure estimate was generated corresponding to exposure to the average and the maximum concentration detected and estimated exposure in that particular medium.

Groundwater

Groundwater is currently not being used; therefore, only a future use scenario was evaluated. Ingestion of 2 liters per day over a 70-year lifetime was assumed for both average and maximum exposure estimates.

Surface Water - Bellamy Reservoir

This water body, currently used as drinking water supply for seven municipalities, has not yet been contaminated by the Site. Potential future use of the Bellamy Reservoir as a drinking water supply was evaluated. Estimated future contamination concentrations were obtained by predicting, via modeling, the flow of contaminated groundwater. The predicted concentrations were considered to be a reasonable maximum exposure scenario. Ingestion of 2 liters per day over a 70-year lifetime was assumed.

Surface Water - Cocheco River and Landfill Perimeter Swale

Ingestion and dermal contact with surface water while swimming or wading in the Cocheco River and dermal contact while wading in the perimeter swale were evaluated as potential current and future exposure scenarios. The current and future use exposure scenarios were considered to be equivalent. The average exposure estimate for the Cocheco River exposure point was based on the assumption that children aged 6 to 16 swim or wade 12 times per year; the maximum exposure estimate was based on a frequency of 24 times per year. The average and maximum exposure estimate for the perimeter swale exposure point was based on the assumption that the children may wade 12 times per year.

Soil/Sediment Exposure

Ingestion and dermal contact with sediment while wading in the perimeter swale were evaluated as potential current and future use exposure scenarios. The average exposure estimate for both current and future use was based on the assumption that children aged 6 to 16 would wade 30 times per year; the maximum exposure estimate was based on a frequency of 90 times per year.

Lifetime cancer risks were determined for each exposure pathway by multiplying the exposure level with the chemical specific cancer potency factor. Cancer potency factors have been developed by EPA from epidemiological or animal studies to reflect a conservative "upper bound" of the risk posed by potentially carcinogenic compounds. That is, the true risk is very unlikely to be greater than the risk predicted. The resulting risk estimates are expressed in scientific notation as a probability (e.g. 1×10^{-6} for 1/1,000,000) and indicate, that an individual is not likely to have greater than a one in one million chance of developing cancer over 70 years as a result of site-related exposure to the compound at the stated concentration. Current EPA practice considers carcinogenic risks to be additive when assessing exposure to a mixture of hazardous substances.

The hazard index was also calculated for each pathway as EPA's measure of the potential for non-carcinogenic health effects. The hazard index is calculated by dividing the exposure level by the reference dose (RfD) or other suitable benchmark for non-carcinogenic health effects. Reference doses have been developed by EPA to protect sensitive individuals over the course of a lifetime and they reflect a daily exposure level that is likely to be without an appreciable risk of an adverse health effect. RfDs are derived from epidemiological or animal studies and incorporate uncertainty factors to help ensure that adverse health effects will not occur. The hazard index is often expressed as a single value (e.g. 0.3) indicating the ratio of the stated exposure as defined to the reference dose value (in this example, the exposure as characterized is approximately one third of an acceptable exposure level for the given compound). The hazard index is only considered additive for compounds that have the same or similar toxic endpoints (for example: the hazard index for a compound known to produce liver damage should not be added to a second whose toxic endpoint is kidney damage).

<u>Summary of Baseline Risk Assessment</u>

Tables 3 through 8 of Appendix B of this ROD depict the carcinogenic and non-carcinogenic risk summary for the contaminants of concern in each exposure pathway described above.

Groundwater

The average and reasonable maximum exposure case carcinogenic risks associated with the potential future consumption of groundwater were approximately 2×10^{-2} (2 cancer cases in 100) and 7×10^{-2}, respectively. Arsenic comprised over 90% of the risk for both the average and reasonable maximum worst case scenarios. Vinyl chloride comprised approximately 5% of the risk for both scenarios. Other chemicals which contributed a risk of greater than one in a million were benzene; chloroethane; 1,1 dichloroethylene; 1,2 dichloroethane; methylene chloride; tetrachloroethylene and trichloroethylene.

For non-carcinogenic effects, the average and reasonable maximum exposure case Hazard Indices exceeded one for the toxic endpoints of keratosis (skin discoloration) and liver effects. Arsenic and tetrahydrofuran were the major contaminants for these toxic endpoints, respectively.

The groundwater contaminant concentrations measured during the FES were used in the Baseline Risk Assessment except for two compounds. Data from the RI was used for tetrahydrofuran which was not analyzed for in the FES and 1,2 dichloroethane which was not detected in the FES.

Surface Water - Bellamy Reservoir

The reasonable maximum exposure case carcinogenic risk associated with the potential future consumption of groundwater was approximately 8×10^{-6}. Over 95% of this risk was due to arsenic.

For noncarcinogenic effects, the Hazard Index was well below one.

Surface Water - Cocheco River and Landfill Perimeter Swale

The reasonable maximum exposure case carcinogenic risks associated with exposure to both the Cocheco River and landfill perimeter swale were well below EPA's risk range of 10^{-6} to 10^{-4}.

For noncarcinogenic effects, the Hazard Index was well below one.

Soil/Sediment Exposure

The average and reasonable maximum exposure case carcinogenic risks due to arsenic associated with exposure to the landfill perimeter swale sediments via the ingestion pathway were approximately 1×10^{-6} and 8×10^{-5}, respectively.

For noncarcinogenic effects the Hazard Indices for the average and reasonable maximum exposure scenario were below one.

Summary

In summary, predicted average and maximum carcinogenic health risks of 2×10^{-2} and 7×10^{-2} for the future use of groundwater exceeded EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6}. Arsenic and vinyl chloride were the major contributors to these risks.

A Hazard Index greater than one was predicted for future use of groundwater. Arsenic and tetrahydrofuran were the major contributors to the noncarcinogenic risks with maximum Hazard Indices of 37 and 24, respectively.

Maximum contaminant levels in groundwater exceeded the applicable regulatory standards set or proposed under the Safe Drinking Water Act - Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) for the following compounds: arsenic; benzene; 1,1 dichloroethylene; 1,2 dichloroethane; tetrachloroethylene; trichloroethylene and vinyl chloride.

The maximum predicted carcinogenic risk for sediment of $8x10^{-5}$ is within EPA's acceptable risk range (10^{-4} to 10^{-6}).

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, and the environment. Specifically an imminent and substantial threat to public health could result from the contaminated soils, sediments, sludges and debris in the Landfill and from drinking groundwater in proximity to the Landfill.

VII. DEVELOPMENT AND SCREENING OF ALTERNATIVES

A. Statutory Requirements/Response Objectives

Under its legal authorities, EPA's primary responsibility at Superfund sites is to undertake remedial actions that are protective of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences, including: a requirement that EPA's remedial action, when complete, must comply with all federal and more stringent state environmental standards, requirements, criteria or limitations, unless a waiver is invoked; a requirement that EPA select a remedial action that is cost-effective and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and a preference for remedies in which treatment which permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances is a principal element over remedies not involving such treatment. Response alternatives were developed to be consistent with these statutory mandates.

Based on preliminary information relating to types of contaminants, environmental media of concern, and potential exposure pathways, remedial action objectives were developed to aid in the development and screening of alternatives. These remedial action objectives were developed to mitigate existing and future potential threats to public health and the environment. These objectives were:

- Prevent the migration of hazardous substances in the landfill to groundwater and surface water and the migration of the groundwater contamination beyond its current extent;

- Reduce risks to human health by preventing exposure to contaminants in groundwater, soils, surface waters, and sediments; and

- Restore contaminated groundwater at and beyond the compliance boundary to State and Federal applicable or relevant and appropriate requirements (ARARs) including drinking water standards, and to a level that is protective of human health and the environment.

B. Technology and Alternative Development and Screening

CERCLA and the NCP set forth the process by which remedial actions are evaluated and selected. In accordance with these requirements, a ınge of alternatives were developed for the Site.

With respect to source control, the FS developed a range of alternatives in which treatment that reduces the toxicity, mobility, or volume of the hazardous substances is a principal element. This range included an alternative that removes or destroys hazardous substances to the maximum extent feasible, eliminating or minimizing to the degree possible the need for long term management. This range also included alternatives that treat the principal threats posed by the site but vary in the degree of treatment employed and the quantities and characteristics of the treatment residuals and untreated waste that must be managed; alternative(s) that involve little or no treatment but provide protection through engineering or institutional controls; and a no action alternative.

With respect to ground water response action, the FS developed a limited number of remedial alternatives that attain site specific remediation levels within different time frames using different technologies as well as a no action alternative.

A Treatability Study was conducted by HMM to provide data to evaluate treatment options for the Site, and to reduce cost and performance uncertainties for various treatment options. The study consisted of an additional sampling episode for sediment, surface water and groundwater. The objective of the sampling round was to determine concentrations of a number of indicator parameters. The parameters analyzed represent an engineering assessment of specific chemical constituents that could affect the implementability or effectiveness of a groundwater remedial technology. Groundwater VOC data was used to determine the high and low ends of VOC loading for a treatment process. Groundwater was sampled to generate filtered arsenic data to help determine the amount of dissolved arsenic in the groundwater. Table 1-3 of the FS lists each parameter or set of analytes sampled as part of the Treatability Study and describes the associated criteria and treatment technologies.

Section 2 of the FS identified, assessed and screened technologies based on implementability, effectiveness, and cost. These technologies were combined into source control (SC) and management of migration (MM) alternatives. Section 3 of the FS presented the remedial alternatives developed by combining the technologies identified in the previous screening process in the categories identified in Section 300.430(e)(3) of the NCP. The purpose of the initial screening was to narrow the number of potential remedial actions for further detailed analysis while preserving a range of options. A limited number of alternatives were then evaluated in Section 4 of the FS.

In summary, of the approximately 9 source control and 4 management of migration remedial alternatives evaluated and screened in Section 3, 4 source control and 4 management of migration alternatives were retained for detailed analysis in Section 4. Tables 3-1 and 3-2 of Section 3 of the FS identify the 4 source control alternatives and 4 management of migration alternatives that were retained through the screening process, as well as those that were not chosen for detailed analysis.

VIII. DESCRIPTION OF ALTERNATIVES

This Section provides a narrative summary of each alternative subject to detailed evaluation. A tabular assessment of each alternative can be found in Tables 3-4 and 3-5 of the Feasibility Study.

A. Source Control (SC) Alternatives Analyzed

Source control alternatives (on-site) were developed for the contaminated soils, sludges, debris and sediments associated with the Landfill as well as the contaminated groundwater located under the Landfill and the contaminated surface water in the perimeter drainage ditch.

The source control alternatives analyzed for the Site include the following alternatives:

- SC-1: No-Action with Long-Term Monitoring;
- SC-2: Limited Action with Long-Term Monitoring/ Access Restriction/ Institutional Controls;
- SC-5/5A: Recontouring of Landfill/ Multi-layer Cap/ Slurry Wall/ Groundwater Recovery System/ Groundwater Treatment/ Discharge to Cocheco River (SC-5) or POTW (SC-5A)/ Geotextile Cover in Drainage Swale/ Erosion Control Blanket; and
- SC-7/7A: Recontouring of Landfill/ Multi-layer Cap/ Interceptor Trench with Internal Landfill Extraction Wells/ Groundwater Treatment/ Discharge to Cocheco River (SC-7) or POTW (SC-7A)/ Selected Sediment Excavation with Consolidation in Landfill.

SC-1: No-Action

This alternative is included in the Feasibility Study, as required by CERCLA, to serve as a basis for comparison with the other source control alternatives being considered.

This alternative would require no remedial action except for long-term monitoring of groundwater, sediments, and surface water. No treatment or containment of disposal areas would occur and no effort would be made to restrict potential exposure to site contaminants. It is possible that a reduction of toxicity of contaminants may occur over time due to natural attenuation, but this may take many decades.

A Site inspection including groundwater and sediment monitoring would be performed four times a year, for 30 years. Samples collected would be analyzed for VOCs, BNAs, and metals. Monitoring data would be evaluated every five years.

This alternative does not meet many ARARs, which include the Safe Drinking Water Act groundwater MCLs, and State and Federal requirements that hazardous waste landfills be capped. In addition, the landfill has a potential for future non-compliance with ARARs such as State and Federal laws protecting the wetlands surrounding the Site and those laws protecting the Class A surface waters of the Bellamy Reservoir.

Estimated Time for Design and Construction: None
Estimated Time for Operation: 30 years, groundwater monitoring
Estimated Capital Cost: None
Estimated Operation and Maintenance Cost (net present worth): $169,000
Estimated Total Cost (net present worth for 30 years at 10% interest):$1,593,400

SC-2: Limited Action

This alternative is similar to SC-1, except that this alternative allows for limited measures to control access to and use of the Site. Warning signs and a fence with barbed wire would be installed to limit any further access to the Site. Institutional controls, such as deed restrictions, and municipal by-laws, where possible, would be implemented to prohibit disturbance of the contaminated source areas and use of the contaminated groundwater.

An inspection and long-term monitoring program similar to alternative SC-1 would be instituted. Also air monitoring would be performed at the Site annually at three locations along the southern, eastern, and northern perimeters of the landfill. Surface water monitoring would be performed at several locations along the perimeter drainage ditch.

While this alternative offers limited protection of human health from the hazards posed by the site, this alternative, like SC-1, provides little or no protection to the environment. In addition, many of the ARARs, such as the SDWA, RCRA, and State hazardous waste regulations, are not met by this alternative. Currently, groundwater contains contaminants which significantly exceed MCLs and the threat to the wetlands and the Bellamy Reservoir remain unchecked.

Estimated Time for Design and Construction: 1 month
Estimated Period for Operation: 30 years, air and groundwater monitoring
Estimated Capital Cost: $44,400
Estimated Operation and Maintenance cost (net present worth): $177,600
Estimated Total Cost (net present worth, for 30 years at @ 10% interest): $1,718,300

SC-5/SC-5A: Recontouring of Landfill/Multi-Layer Cap/Slurry Wall/Groundwater Treatment/Discharge to Cocheco River or POTW:

Alternative SC-5/SC-5A would involve recontouring of the landfill, construction of a multi-layer cap and a slurry wall to contain groundwater migration, on-site groundwater treatment (SC-5) or pretreatment (SC-5A), and final discharge to the Cocheco River (SC-5) or the Publicly Owned Treatment Works (POTW) (SC-5A).

Approximately 300,000 cubic yards of soils and debris from the toe of the side slopes and from the sediments in the drainage ditch would be consolidated into the Landfill to contour features of the Landfill prior to capping. Recontouring of the Landfill may reduce the amount of clean soil, necessary to achieve a maximum allowed slope of 5 percent, from 1,200,000 cubic yards to 850,000 cubic yards.

After the Landfill has been recontoured, backfilled and compacted, a multi-layer cap system will be constructed. The multi-layer cap would consist of a vegetative layer including topsoil and common fill, filter fabric, a drainage layer, a flexible membrane liner and a low permeability soil layer, and a gas (methane) vent layer directly over the buried solid wastes. Figure 10 is a cross-section of a typical multi-layer cap. Alternative SC-5/5A proposed the installation of a 12-inch sand layer as the material to be used for the drainage layer of the multi-layer cap, 2-feet of a compacted soil (with a hydraulic permeability of less than or equal to 10^{-7} cm/sec) in the low permeability layer and a 20 mil flexible membrane liner.

A slurry wall and a groundwater recovery system would be constructed around the perimeter of the landfill down to the clay layer. Construction of the slurry wall may be difficult because the bottom of the slurry wall must be keyed into the marine clay layer, which varies widely in depth and thickness. This method also risks puncturing the protective clay "lens" which may allow contaminated groundwater from the upper aquifer to migrate into the uncontaminated lower aquifer. Installation of the cap, slurry wall and groundwater recovery system eliminates the use of the perimeter drainage ditch as an avenue for contaminant migration, thereby limiting exposures to contaminated surface water and sediments.

The groundwater treatment system would consist of a sequencing batch reactor such as the Powdered Activated Carbon Treatment System (PACT™) or an air stripper, pending pre-design pilot study results. The FS chose the PACT™ system to describe and provide a cost analysis for the FS. In the PACT™ System the contaminated groundwater would first enter an aeration tank to remove VOCs; activated carbon present in the tank would remove non-volatile organic chemicals from the water. The water would then pass through a settling tank where flocculation, coagulation and precipitation processes take place to remove metals and suspended solids. The metals and solids settle at the bottom of the tank in the form of a sludge. If it is a RCRA waste, sludge will be disposed of at a permitted RCRA facility. The water would then pass through a multi-media filter and ultimately be discharged into the Cocheco River. A schematic of the proposed groundwater treatment system is shown in Figure 11 of this Record of Decision.

If discharge to the POTW is utilized, the construction of a pretreatment system may be required to meet the intake requirements of the Dover POTW. The pretreatment process would focus primarily on reducing suspended metals and solids. An approximately 2.5 mile piping system would be constructed to transport the pretreated groundwater to the POTW. The Dover POTW currently has the extra capacity to handle pre-treated water from the Landfill, and the capacity is expected to increase further by 1992 with the start-up of a secondary treatment unit, currently under construction.

This Alternative would also involve the installation of cover material over the drainage swale which drains from Glen Hill Road adjacent to the landfill down into the Cocheco River in order to minimize human and wildlife exposure to the contaminated sediments and minimize the potential migration of contaminated sediments in the surface water flow of the swale.

This alternative meets all ARARs.

SC-5 Cost Estimate (discharge to Cocheco River option):
Estimated Time for Design and Construction: 3-4 years
Estimated Period for Operation:30 years
Estimated Capital Cost: $31,266,600
Estimated Operation and Maintenance Cost (net present worth): $221,400
Estimated Total Cost (net present worth for 30 years at 10% interest): $33,353,600

SC-5A Cost Estimate (discharge to POTW option):
Estimated Time for Design and Construction: 3-4 years
Estimated Period for Operation:30 years
Estimated Capital Cost: $31,334,600
Estimated Operation and Maintenance Cost (net present worth): $206,000
Estimated Total Cost (net present worth for 30 years at 10% interest): $33,267,100

SC-7/7A: Recontouring of Landfill/ Multi-Layer Cap/ Interceptor Trench/ Discharge to Cocheco River or POTW:

Alternative SC-7/SC-7A would involve recontouring of the landfill, construction of a multi-layer cap and an interceptor/diversion trench around the perimeter of the landfill to contain and collect contaminated groundwater and divert clean groundwater, an on-site groundwater treatment (SC-7) or pretreatment (SC-7A), and final discharge to the Cocheco River (SC-7) or the Publicly Owned Treatment Works (POTW) (SC-7A).

This alternative would involve recontouring the existing landfill and construction of a multi-layer cap over the recontoured landfill. Recontouring would involve the excavation of up to 300,000 cubic yards of on-site fill material from the perimeter of the landfill and depositing it on the landfill center to achieve the necessary slope for proper drainage. Approximately 250,000 cubic yards of clean fill would also be required for the minimum 3 percent slope allowed.

The 55-acre multi-layer cap would be constructed after the existing landfill had been recontoured, backfilled, and compacted. The cap would consist of a vegetative layer including topsoil and common fill, a geocomposite drainage layer, a flexible membrane liner, a synthetic low permeability layer, and a gas (methane) vent layer directly over the buried solid wastes. Figure 10 is a cross-section of a typical multi-layer cap. Alternative SC-7/7A proposed the use of a geocomposite as the drainage layer material, a 40 mil flexible membrane liner and a low-permeability bentonitic blanket for the low permeability layer (with a hydraulic permeability of less than or equal to 10^{-7} cm/sec).

A groundwater recovery system would consist of an upgradient groundwater diversion trench to intercept clean groundwater before it flows into the landfill system and a downgradient interceptor trench/extraction well system, or combination system, to collect groundwater/leachate, which currently migrates from the site. The interceptor/diversion trench system would extend around the entire existing landfill perimeter. Inside the trench, a one foot diameter perforated pipe, wrapped in filter fabric, and a drainage net would be connected to a series of manholes. Submersible pumps housed in the manholes would extract collected groundwater. This system would be designed to lower the groundwater table beneath the landfill's refuse. Extraction wells will be placed within the landfill boundaries to lower groundwater below the waste material. Collected contaminated groundwater would be conveyed to an on-site groundwater treatment system with discharge to the Cocheco River or the Dover POTW after pre-treatment. Clean groundwater in the upgradient diversion trench would be diverted to either the surrounding wetland system or the Cocheco River without being mixed with contaminated water. The installation of the cap and the interceptor/diversion trench system eliminates the perimeter drainage ditch as an avenue for contaminant migration and limits potential human and wildlife exposure to Site contaminants.

The actual on-site treatment system(s) that will be used at the site will be determined during pre-design studies and will include a sequencing batch reactor such as the Powered Activated Carbon Treatment System or an air stripper. The FS described the Powered Activated Carbon Treatment System (PACT™), summarized above in

Alternative SC-5/5A.

If the POTW option is utilized, the construction of a pretreatment system which would meet the intake requirements of the Dover POTW, may be required. The pretreatment process would focus primarily on reducing suspended metals and solids. As was described in SC-5/5A, the Dover POTW currently has the extra capacity to handle some pre-treated water from the landfill.

The sediment control component provides for predesign sampling to identify specific areas of sediment deposition along the drainage swale that could contain concentrations of contaminants in excess of the cleanup levels. Based on the physical characteristics of the drainage swale, the extent of contamination is expected to be limited. Contaminated sediments will be removed with little or no heavy equipment; sediments will likely be removed by hand shovel. This method was evaluated because of the difficulties associated with getting heavy equipment into and out of the steep-sloped swale. This approach, will reduce the overall impact to the environment during implementation as compared to using heavy equipment.

This alternative meets all ARARs.

SC-7 Cost Estimate (discharge to Cocheco River option):
Estimated Time for Design and Construction: 3-4 years
Estimated Period for Operation: 30 years
Estimated Capital Cost:$20,014,700
Estimated Operation and Maintenance Cost (net present worth):
$239,300
Estimated Total Cost (net present worth for 30 years at 10% interest):$22,273,600

SC-7A Cost Estimate (POTW option):
Estimated Time for Design and Construction: 3-4 years
Estimated Period for Operation: 30 years
Estimated Capital Cost:$20,174,700
Estimated Operation and Maintenance Cost (net present worth):
$211,900
Estimated Total Cost (net present worth for 30 years at 10% interest):
$22,171,900

B. Management of Migration (MM) Alternatives Analyzed

Management of migration alternatives address contaminants that have migrated beyond the boundaries of the Landfill. At the Dover Site, contaminants have migrated from the Landfill into groundwater east towards the Cocheco River, and also south towards the Bellamy Reservoir. The primary groundwater threat to human health and the environment is in that portion of the groundwater contaminant plume flowing south towards the Bellamy Reservoir.

The Management of Migration alternatives evaluated for the Site include the following alternatives:

MM-1: No Action with Long-Term Monitoring;

MM-2: Limited Action with Long-Term Monitoring/ Institutional Controls;

MM-3: Groundwater Interceptor Trench/ Groundwater Treatment/ Hydraulic Barrier/ Discharge to Wetlands; and

MM-4: Groundwater Extraction Wells/ Groundwater Treatment/ Discharge to Wetlands and Cocheco River.

MM-1 No-Action

This alternative was evaluated in detail in the FS to serve as a baseline for comparison with the other remedial alternatives under consideration. Under the No Action alternative, there would be no removal, containment, or treatment of off-site contaminated groundwater. However, this alternative would require long-term groundwater monitoring, as is described under Alternative SC-1.

This alternative combined with alternatives SC-5/5A or SC-7/7A, would achieve over time the chemical specific ARARs, through natural attenuation. Natural attenuation times frames for the groundwater to attain cleanup levels are 5 to 7 years in the eastern plume (groundwater contamination flowing in the direction of the Cocheco River) and 10 to 24 years in the southern plume (groundwater contamination flowing in the direction of the Bellamy Reservoir), after the implementation of an active source control alternative. However, during this period of natural attenuation, contaminated groundwater east and south of the site poses a threat to human health and the environment. In addition, contaminants may reach the waters of the Bellamy Reservoir.

Estimated Time for Design and Construction: None
Estimated Period of Operation: 30 years
Estimated Capital Cost: None
Estimated Operation and Maintenance Cost (net present worth): $142,800
Estimated Total Cost (net present worth for 30 years at 10% interest): $1,346,500

MM-2: Limited Action:

Management of Migration Alternative MM-2, Limited Action, provides long-term monitoring of the off-site contaminated groundwater for at least 30 years. In addition, under this alternative institutional controls will be employed where possible, limiting Site access, Site use, and preventing the use of groundwater from the upper aquifer for potable and municipal usage. These institutional controls will be implemented regardless of which management of migration alternative (except for no action, MM-1) is implemented. The City of Dover passed a zoning ordinance in February 1991 that restricts the use of groundwater within 1500 feet of the landfill as a potable water supply.

A long-term groundwater sampling and monitoring program will be developed and implemented. This may include the installation of additional wells, including the area of the plume closest to the Bellamy Reservoir. The monitoring will further define groundwater contaminant concentrations and the extent of migration towards the Bellamy Reservoir.

This alternative, coupled with SC-5/5A or SC-7/7A, would achieve over time the chemical specific ARARs through natural attenuation. Natural attenuation times frames for the groundwater to attain cleanup levels are 5 to 7 years in the eastern plume and 10 to 24 years in the southern plume, after the implementation of an active source control alternative. While this alternative provides more protection to humans from contaminated groundwater during natural attenuation, it does nothing to prevent contaminants from reaching the Bellamy Reservoir.

Estimated Time for Design and Construction: 6 months
Estimated Period of Operation: 30 years
Estimated Capital Cost: None
Estimated Operation and Maintenance Cost (net present worth): $176,541
Estimated Total Cost (net present worth for 30 years at 10% interest): $1,673,593

MM-3: Groundwater Interceptor Trench/Recharge Trench/Hydraulic Barrier:

Management of migration alternative MM-3, includes the construction of a groundwater interceptor trench at the leading edge of the groundwater contaminant plume on the southern and southeastern sides of the landfill. Installation of this trench would passively collect contaminated groundwater, which has migrated into the wetlands adjacent to the Landfill, thereby limiting the further spread of the plume. Contaminated groundwater collected by the trench would be pumped to a treatment unit on or adjacent to the Landfill. The treated groundwater would then be recharged downgradient of the trench.

The interceptor trench would be located off-site south and southeast of the Dover Landfill extending laterally approximately 2,200 linear feet. An approximately 4-foot wide by 25-foot deep trench would be excavated and dewatered prior to laying the pipe. The bedding inside the trench would include gravel and a perforated pipe wrapped with filter fabric. After placement of the bedding material, the trench would be backfilled to surface grade. The recharge trench would be located downgradient of the interceptor trench and also extend about 2,200 linear feet. An approximately 2-foot wide by 4-foot deep recharge trench would be excavated and HDPE corrugated, perforated pipe would be installed. Gravel would be placed around the pipe to promote drainage. Groundwater collected by the interceptor trench would be pumped from a manhole via a submersible pump to an on-site groundwater treatment facility. A portion of the treated groundwater would be returned to the management of migration area via the recharge trench. This would minimize localized dewatering of the wetlands which would reduce the adverse impact of this activity. Treated groundwater in excess of that which could be recharged would be discharged to the river. Trench installation would adversely impact wetlands along the southern and southeastern portions of the Landfill. However, once the trench and associated piping have been installed any wetland areas impacted by excavation and installation procedures can be restored. Actual design configuration of the interceptor-recharge system would be dependent upon additional data and analysis obtained during predesign activities.

Groundwater treatment technologies previously identified for the source control alternatives apply as well to this alternative.

The cleanup time frames for this alternative are estimated to be 3 to 5 years for the eastern plume area and 10 to 24 years for the southern plume, after the implementation of an active source control alternative.

Implementation of this alternative in conjunction with a source control alternative which involves treatment would allow all ARARs to be met. Construction of the groundwater interceptor trench and a groundwater recharge trench in the wetlands and the associated treatment system would alter portions of the wetlands. All construction activities associated with the implementation of this alternative will be coordinated with federal and state authorities and meet the substantive legal requirements of federal and state wetland protection laws. Key ARARs include the SDWA MCLs; Executive Orders EO 11988 and 11990 and 40 CFR 6 Appendix A (concerning the protection of wetlands and floodplains); the Clear Water Act; the New Hampshire Criteria and Conditions for Fill and Dredging in Wetlands; and the New Hampshire Rules Relative to Prevention of Pollution from Dredging, Filling, Mining, Transporting and Construction.

Figure 12 presents the conceptual layout for this alternative.

Estimated Period for operation: 10 years
Estimated Capital Cost: $1,452,200
Estimated Operation and Maintenance Cost (net present worth): $78,800
Estimated Total Cost (net present worth for 10 years at 10% interest): $1,936,600

The cost of long-term (semi-annual) monitoring is estimated as follows:

Estimated Period for Operation: 30 years
Estimated Capital Cost: $9,400
Estimated Operation and Maintenance Cost (net present worth): $93,600
Estimated Total Cost (net present worth for 30 years at 10% interest): $892,100

Total cost, MM-3 and long-term monitoring: $ 2,828,700

MM-4: Groundwater Extraction Wells and Treatment System:

Alternative MM-4 is designed to collect and treat contaminated groundwater which has migrated from the landfill in both the southern and eastern directions. It differs from Alternative MM-3 only in that the interceptor trench would be replaced by a series of recovery wells. This alternative would consist of the following: the installation of several groundwater extraction wells at off-site locations on the southern and eastern sides of the site; the on-site treatment of contaminated groundwater; the recharge of the treated water to wetlands downgradient of the wells and/or discharge of the treated water to the Cocheco River. Groundwater collected by the extraction wells would be pumped at a total of approximately 125 gpm to a treatment unit on or adjacent to the Landfill.

The estimated time to achieve cleanup levels is contingent on the aquifer characteristics, retardation, plume mass and areas of extraction. Based on these factors, MM-4 would be located in approximately the same place as MM-3, as shown in Figure 13. The cleanup time frames for this alternative are estimated to be 3 to 5 years for the eastern plume area and less than 10 to 24 years for the southern plume, after the implementation of a source control alternative.

Implementation of this alternative in conjunction with a source control alternative which involves treatment would allow all ARARs to be met. Wetland mitigation measures and restoration efforts would be required in order to comply with the Location Specific ARARs, as discussed for Alternative MM-3. However, this alternative would have less detrimental impact on the wetlands than MM-3. All ARARs will be met.

Estimated Period for Operation: 10 years
Estimated Capital Cost: $1,503,700
Estimated Operation and Maintenance Cost (net present worth): $394,200
Estimated Total Cost (net present worth for 10 years at 10% interest): $3,925,900

The cost of long-term (semi-annual) monitoring is estimated as follows:

Estimated Period for Operation: 30 years
Estimated Capital Cost: $9,400
Estimated Operation and Maintenance Cost (net present worth): $93,600
Estimated Total Cost (net present worth for 30 years at 10% interest): $892,100

Total cost MM-4 and long-term monitoring: $ 4,818,000

IX. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 121(b)(1) of CERCLA presents several factors that EPA must consider in its assessment of alternatives. Building upon these specific statutory mandates, the National Contingency Plan articulates nine evaluation criteria to be used in assessing the individual remedial alternatives.

A detailed analysis was performed on the alternatives using the nine evaluation criteria in order to select a Site remedy. The following is a summary of the comparison of each alternative's strength and weakness with respect to the nine evaluation criteria. These criteria and their definitions are as follows:

Threshold Criteria

An alternative must meet the two threshold criteria described below in order to be eligible for selection in accordance with the NCP.

1.**Overall protection of human health and the environment** addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering controls, or institutional controls.

2.**Compliance with ARARS** addresses whether or not a remedy will meet all of the ARARs of other Federal and State environmental laws and/or provide grounds for invoking a waiver.

__Primary Balancing Criteria__

The following five criteria are used to compare and evaluate the elements of alternatives which have met the threshold criteria to each other.

3.**Long-term effectiveness and permanence** addresses the criteria that are utilized to assess alternatives for the long-term effectiveness and permanence they afford, along with the degree of certainty that they will prove successful.

4.**Reduction of toxicity, mobility, or volume through treatment** addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the site.

5.**Short term effectiveness** addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup levels are achieved.

6.**Implementability** addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

7.**Cost** includes estimated capital and Operation & Maintenance (O&M) costs, as well as present-worth costs.

__Modifying Criteria__

The modifying criteria are used on the final evaluation of remedial alternatives generally after EPA has received public comment on the RI/FS and Proposed Plan.

8.**State acceptance** addresses the State's position and key concerns related to the preferred alternative and other alternatives, and the State's comments on ARARs or the proposed use of waivers.

9. **Community acceptance** addresses the publics general response to the alternatives described in the Proposed Plan and RI/FS report.

Following the detailed analysis of each individual alternative, a comparative analysis, focusing on the relative performance of each alternative against the nine criteria, was conducted. This comparative analysis can be found in Section 4, Tables 4-22 and 4-23 of the Feasibility Study.

The section below presents the nine criteria and a brief narrative summary of the alternatives and the strengths and weaknesses according to the detailed and comparative analysis.

1. **Overall Protection of Human Health and the Environment**
Alternatives SC-7/7A and SC-5/5A would provide overall protection to human health by preventing direct contact, ingestion, and inhalation of site contaminants. These alternatives would provide dermal contact protection from on-site contaminants due to the construction of the multi-layer landfill cap. There were no hot spots found in the landfill that would warrant treatment. Both alternatives minimize the further off-site migration of leachate and contaminated groundwater and provide for treatment of the collected contamination.

Alternatives SC-1 and SC-2, the No Action and Limited Action Alternatives, would not meet this criterion in its entirety. Alternative SC-2 provides for certain protective measures to secure the site from unauthorized entry, and would reduce the potential for direct contact with and possible ingestion of contaminated materials at the site. Inhalation hazards from airborne dust particles or VOC emissions could be a factor if the Landfill were to be disturbed at some point in the future.

Alternatives MM-2, MM-3 and MM-4, would provide overall protection to human health as long as the groundwater is not used as a drinking water source. Off-site groundwater contamination is reduced through natural attenuation as described under MM-1 and MM-2 and by groundwater extraction and treatment as described under alternatives MM-3 and MM-4. MM-3 and MM-4 would provide overall protection to human health and the environment by controlling the migration of contaminated groundwater thereby preventing further contamination of the aquifer and neighboring wetlands. Alternative MM-4 would provide a shorter cleanup time than MM-3, because of increased groundwater extraction rates. Alternative MM-1 (the no action alternative) would provide no protection of human health from groundwater contamination. Neither MM-1 nor MM-2 protect the Class A waters of the Bellamy from contamination during the period of natural attenuation.

2. Compliance with ARARs

Each alternative was evaluated for compliance with ARARs, including chemical-specific, action-specific and location specific ARARs. These alternative specific ARARs are presented in Section 4 of the FS.

With the exception of the no action (SC-1) and the limited action (SC-2) source control alternatives, all of the other source control alternatives would meet all ARARs. SC-1 and SC-2 does not comply with RCRA regulations and the New Hampshire regulations for the design, closure and post closure requirements of the Landfill and General Facility Standards. In addition, SC-1 and SC-2 allow contaminants in excess of MCLs to migrate from the site. Further degradation of the current landfill cover and the leachate trench also poses a threat to the wetlands, the Cocheco River and the Bellamy Reservoir in contravention of Federal and State laws protecting wetlands, flood plains, and Class A drinking water sources. Alternatives SC-7A and SC-5A will have to meet POTW discharge requirements.

All of the management of migration alternatives would over time meet Federal and State ARARs if implemented in conjunction with a preferred source control alternative. However, during the natural attenuation period MM-1 fails to protect human health from groundwater containing contaminants in excess of MCLs south and east of the site. Also, MM-1 fails to protect the Bellamy Reservoir from the migration of the southern plume. Alternative MM-2 includes institutional controls to assist in protecting humans from consumption of contaminated groundwater, yet do nothing in the short term to protect the waters of the Bellamy Reservoir.

Alternative MM-3, and to a lesser extent, alternative MM-4, have significant short-term adverse impacts on the wetlands to the south and east of the Site as a result of construction and monitoring to take place in them. However, they meet the NCP's mandate of groundwater cleanup in a reasonable time. Alternatives MM-3 and MM-4 would have to comply with additional action specific ARARs such as state and federal groundwater discharge limits and other applicable groundwater anti-degradation regulations.

The management of migration alternatives would meet few if any ARARs if implemented without an active source control portion of the remedy. The time frame to attain cleanup levels would increase significantly due to the continued release of contaminants into the groundwater from the Landfill.

In the long term all of the management of migration alternatives achieve compliance with chemical specific ARARs; however, the alternatives differ in the time it takes to achieve compliance.

3. Long-term Effectiveness and Permanence

The No Action (SC-1) and Limited Action (SC-2) alternatives would not be effective or permanent in reducing long-term risk; all of the contaminants will remain at the Site and continue to leach into the groundwater.

Alternative SC-7/7A and alternative SC-5/5A provide effective, long-term reduction in leachate generation, control of landfill gases, and eliminate the potential for dermal contact with untreated wastes. Both alternatives require the construction of a multi-layer (composite) cap on the Landfill that provides long-term minimization of precipitation infiltration, resulting in a reduction in the amount of leachate generated. They also require the construction of a leachate collection system - either a slurry wall or an interceptor trench - both of which provide for long term reduction of clean water entering the Landfill and long term collection of contaminated water leaving the Landfill. Both alternatives provide for treatment of the contaminated leachate and groundwater.

All of the Management of Migration Alternatives, provide an equal degree of long-term effectiveness and permanence, when instituted with an active source control alternative. Alternatives MM-3 and MM-4 employ treatment of contaminated groundwater to meet cleanup levels for VOCs and metals. Alternatives MM-1 and MM-2 do not propose any action to remediate the contaminated groundwater but rely on natural attenuation processes, over time, to attain the groundwater cleanup levels. The primary difference in these alternatives are the times they take to meet clean up levels and the protection they afford in the short run. Both MM-3 and MM-4 provide significantly more protection in the short run to the Bellamy Reservoir.

4. Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives SC-1 and SC-2 would not provide a reduction in contaminant toxicity, mobility, or volume through treatment because these alternatives do not provide for treatment. Alternatives SC-7/7A and SC-5/5A are similar in their ability to achieve the cleanup levels for groundwater at and beyond the point of compliance by effectively reducing contaminant toxicity, mobility, and volume through collection and treatment of the groundwater/leachate prior to discharge. Alternatives SC-7/7A and SC-5/5A would reduce the mobility of the contaminants in soil and sediments but would not reduce the volume or toxicity because direct treatment of these materials is not practicable.

Alternatives MM-1 and MM-2 would not provide any reduction in toxicity, mobility, or volume of any groundwater contaminants through treatment. Alternatives MM-3 and MM-4 would reduce toxicity, mobility, and volume through treatment since both alternatives would employ collection and treatment of contaminated groundwater prior to discharge.

5. Short-term Effectiveness

Alternatives SC-1 and SC-2 would not have any short term impacts from construction and implementation activities. Alternatives SC-5/5A and SC-7/7A have the potential for release of contaminants during construction activities especially during the recontouring of the landfill and the digging of the trench or slurry wall. However, special engineering precautions would be taken to minimize the potential for air releases of contaminants to ensure protection of workers and area residents during cleanup related construction activities. These measures include interim foam covers, enclosed cabs on backhoes and hydraulic excavators, and dust and odor suppression techniques to control fugitive dust emissions. Additionally, since active measures are being taken to control and intercept the migration of contaminated groundwater/leachate, attainment of groundwater cleanup levels at the compliance boundary will occur sooner than with SC-1 and SC-2.

Some increase in traffic and noise pollution would be expected from activities under SC-5/5A and SC-7/7A, especially from the import of off-site fill needed to construct the cap. Short term effectiveness would be somewhat lower for SC-5A and SC-7A relative to SC-5 and SC-7 due to the construction impacts from the 2.5 mile sewer connecting to the POTW. The total construction periods are estimated to be 3-4 years for SC-5/5A and 2-3 years for SC-7/7A.

Neither MM-1 nor MM-2 poses a threat to human health or the environment as a result of construction or implementation. Alternatives MM-3 and MM-4 would have short-term impacts to adjacent wetlands during construction. Construction of the groundwater recovery wells and recharge system in MM-4, plus associated transmission piping may negatively impact the wetland vegetation in the construction area. An area 10 feet wide and 2,000 feet long would be extensively disturbed in order to install the extraction wells and piping. The construction of the interceptor and recharge trenches under MM-3 require an even larger impact due to construction activities. An access roadway along the perimeter of the trench would be necessary to transport the material for construction as well as providing a staging area for the excavated soils. Both alternatives have the potential to affect the water balance of the wetlands due to pumping and discharge. Recharging of the treated groundwater is expected to minimize the dewatering of the wetlands.

Alternatives MM-1 and MM-2 employ natural attenuation and are expected to attain cleanup levels in the eastern plume in 5 to 7 years and 10 to 24 years in the southern plume after the implementation of an active source control remedy. In the eastern plume, MM-3 and MM-4 offer an improvement over MM-1 and MM-2: 3 to 5 years vs. 5 to 7 years. In the southern plume, because MM-3 relies on the natural flow of groundwater, the time frame for MM-3 clean up will not be a significant improvement over MM-1 and MM-2. The time frame for MM-4 cleanup of the southern plume will depend largely upon the rate that the contaminated groundwater can be extracted from the aquifer; it is expected to be an improvement over the MM-3 time frame. Alternatives MM-3 and MM-4 offer significantly better protection for the Bellamy Reservoir in the short term; contaminants will be prevented from migrating closer to the reservoir by these two alternatives.

6. **Implementability**

Alternatives SC-5/5A, SC-7/7A, MM-2, MM-3, MM-4 are implementable, are well-developed technologies, and have been used successfully at other sites. The recontouring activities present some potential for encountering hazardous waste. Preliminary studies and special construction procedures would be used to minimize this potential. Hot spots, consisting of highly toxic and/or highly mobile material which present a potential principal threat to human health or the environment, once exposed by recontouring would have to be tested, removed, treated and disposed of in an off-site RCRA TSD facility. The multi-layer cap and PACT™ systems of SC-5/5A and SC-7/7A have been installed on many other sites. Obtaining clay of sufficient volumes for the low permeability layer of the cap may be difficult under alternative SC-5/5A.

Sufficient land is available for operation of the groundwater/leachate treatment system and its supporting facilities for SC-5/5A and SC-7/7A. Preliminary bench-scale and pilot-scale testing would have to be performed prior to implementation of the groundwater treatment system. No major technical problems are anticipated.

The interceptor trench/barrier wall of SC-7/7A would require less technical and support equipment resources to install than the slurry wall of SC-5/5A. The design and construction of the sediment cover (SC-5/5A) in the drainage swale down to the Cocheco River would not pose any unique implementation problems. However, the limited excavation provided for in SC-7/7A would be much easier and quicker to implement. Construction activities would have to be scheduled during seasonal low flows to minimize potential impacts on the Cocheco River. The sediment removal activity under SC-7/7A poses no significant implementability problems.

An expansion of the Dover POTW is currently under construction and is expected to be in place by 1992. It should be able to provide adequate treatment capacity for the Site's pre-treated groundwater and leachate as an alternative (SC-5A and SC-7A) to discharging to the Cocheco River.

Alternatives SC-1, SC-2, MM-1 and MM-2 can be accomplished with little difficulty and use well established and reliable monitoring and analytical procedures. However, some of the proposed institutional controls may be difficult to implement.

Alternatives MM-3 and MM-4 are both easily implemented. MM-3's trench construction in wetlands is somewhat more difficult than MM-4's extraction wells. Also, MM-4 would be implemented more easily for a deeper zone of contamination than would the trench.

7. Cost
The estimated present worth value of each alternative and the options are as follows:

COST COMPARISON OF SOURCE CONTROL ALTERNATIVES

			Capital Costs	O & M	Present Worth
SC-1	No Action	$	0	169,000	1,593,400
SC-2	Limited Action		44,400	177,600	1,718,300
SC-5	Recontour/Multi-Layer Cap/ Slurry Wall/ Groundwater Treatment/ Discharge to Cocheco River/ Sediments Cover		31,266,600	221,400	33,353,600
SC-5A	Recontour/Multi-Layer Cap/ Slurry Wall/ Groundwater Treatment/ Discharge to POTW/ Sediments Cover		31,334,600	205,000	33,267,100

SC-7	Recontour/Multi-Layer Cap/ Interceptor/ Diversion Trench/ Groundwater Treatment/ Discharge to Cocheco River/ Sediments Excavation	20,014,800	239,300	22,270,600
SC-7A	Recontour/Multi-Layer Cap/ Interceptor/ Diversion Trench/ Groundwater Treatment/ Discharge to Cocheco River/ Sediments Excavation	20,174,700	211,862	22,171,900

COST COMPARISON OF MANAGEMENT OF MIGRATION ALTERNATIVES

		Capital Costs	O&M Costs ($/Yr)	Long-Term Monitoring	Present Worth
MM-1	No Action	$ 0	142,834	*	1,346,482
MM-2	Limited Action	9,356	176,541	*	1,673,593
MM-3	Groundwater Interceptor Trench/Recharge Trench/ Groundwater Treatment	1,452,154	78,840	892,200	2,828,738
MM-4	Groundwater Extraction Wells and Treatment System	1,503,699	394,200	892,200	4,818,047

* Long-term monitoring costs are included in the capital and O & M costs for these remedies.

8. State Acceptance

The New Hampshire Department of Environmental Services (NHDES) has been involved in the study and oversight of the Site since the late 1970's, as summarized in Section II of this document. The Remedial Investigation was performed as a state lead through a cooperative agreement between the state and EPA. The NHDES has reviewed this document and concurs with the source control and eastern plume management of migration portions of the selected remedy and has reserved a concurrence decision on the southern plume management of migration portion of the selected remedy until pre-design studies have been completed. A copy of the declaration of concurrence is attached as Appendix D.

9. Community Acceptance

The comments received during the public comment period and the and the public hearing on the Proposed Plan and FS are summarized in the attached document entitled "The Responsiveness Summary" (Appendix G). In addition, a summary of the comments appears below.

A large number of comments were submitted by citizens of Dover and Madbury as well as their community leaders and representatives, both at the public hearing and in writing during the public comment period, arguing that the taxpayers of these two towns could not bear the costs of the proposed remedy. Many of these commentors argued that the EPA should take no action other than long term monitoring, while others argued that a less effective cap would suffice. It should be noted that prior to the public comment period, the City of Dover and the Town of Madbury had been issued general notice of potential liability for the cleanup of the Site thus giving rise to the possibility that local taxpayers will bear some portion of the cleanup cost.

One resident from the community wrote that placing a fence around the Site will not protect anyone from possible hazards of the contamination, does not feel residents should be penalized for the PRPs' unwillingness or inability to correct mistakes made in the past, and hopes that EPA takes into consideration the effect of a Limited Action Plan on the people and property values around the Landfill. The Public Works Department of the City of Portsmouth commented on the proposed plan stating it agreed with the EPA's preferred alternative. It also noted that if the Bellamy Reservoir were contaminated, the cost of replacing it would far exceed the cost of the remedial action proposed for the Landfill.

The PRPs submitted seven comments, an alternative to EPA's proposed cleanup plan, and a public health evaluation report. The seven comments are summarized as follows: 1) the PRPs want to see a

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